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National intellectual capital influence on economic growth in the European Union countries

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Abstract
Research background: Importance of intangible resources for country's economic growth is widely recognized. However, empirical evidence of this influence is hard to show due to measurement limitations of intangible resources. Majority of empirical studies concentrates on the analysis of a specific type of intangible resource's influence on economic growth. National intellectual capital concept provides background for an integrated assessment of the country's intangible resources. This new approach enables the estimation of intangible resources' influence to economic growth in a more complex way.
Purpose of the article: a) To examine various scientific approaches of the national intellectual capital and its impact on the economic growth; b) to offer a measurement model of the national intellectual capital influence on economic growth; c) to evaluate the specific European Union countries' intellectual capital's effect on their economic growth.
Methods: Econometric analysis; refined factor value computation method using the standardized regression coefficients; the SAW method; expert evaluation, cluster analysis; correlation and regression analyses.
Findings & Value added: A review of the economic growth theories showed that structural components of intellectual capital (human capital, structural capital, social capital, relational

capital) in economic growth theories are analyzed as key determinants of economic growth. Our proposed research methodology consists time lag between variables and this let us evaluate casual relation. Empirical analysis of 25 European Union countries' intellectual capital's effect on their economic growth rate revealed that national intellectual capital and the countries' level of economic development have statistically significant impact on economic growth rate. The analysis of intellectual capital components' influence on economic growth rate of 25 European Union countries showed that only human capital and the level of economic development have statistically significant influence. A more comprehensive human capital's influence on economic growth analysis revealed that 63.1 percent of the long-term economic growth rate in 25 European Union countries can be explained by differences in their economic development level and differences in educational achievement factor values. Moreover, analysis of national intellectual capital effect on economic growth in separate clusters allowed to identify influence differences in each group of countries.

Introduction

Expansion of new technologies has changed our understanding of economy and main factors of production. Scientists highlight the importance of intangible resources as key enablers of innovation and economic growth. This trend encourages revising indicators of economic growth and finding better measurement models for intangible resources. Measurement of intangible resources is a complex task due to their specific nature, such as their incapability of being perceived by the sense of touch. It is even more difficult to evaluate interdependence of intangibles and economic growth.

National intellectual capital concept has recently emerged as a new area of research, where the focus is on understanding and measuring the intangible factors influencing national wealth creation. The researchers have developed various national intellectual capital measurement models, however national intellectual capital and economic growth interdependence is rarely empirically analyzed. National intellectual capital concept enables to investigate the impact of intangibles on economic growth by constructing a comprehensive, multidimensional measurement framework that completes and combines the viewpoints provided by different knowledge society frameworks.

In this article, interdependence of national intellectual capital and economic growth rate is investigated in 25 European Union (EU) countries during the period of 2002–2015. The aim of this research is to determine national intellectual capital and its components' impact on economic growth in EU countries. The objectives are as follows: to examine various scientific approaches of the national intellectual capital and its impact on the economic growth; to offer the national intellectual capital influence on economic growth measurement model; to evaluate the specific EU countries' intellectual capital's effect on their economic growth.

National intellectual capital value is measured as an index using refined factor value computation and SAW methods; influence on economic growth is evaluated using cross-country panel regression analysis.

Article is composed of four parts. In first part the theoretical aspects of national intellectual capital and its influence on economic growth is analyzed. Second part presents measurement methodology. Third part presents the empirical evaluation of national intellectual capital influence on European countries' economic growth. The article ends with discussion and conclusions.

The theoretical aspects of national intellectual capital and its influence on economic growth

The concept of intellectual capital was primarily developed at the company level, where intellectual capital was recognized as a valuable resource. Gradually the concept started to be considered on national scale (Michalczuk & Fiedorczuk, 2016). Serenko and Bontis (2013) identify that this shift is natural stage of normal science development. Intellectual capital research is at the theoretical consolidation stage, and is progressing towards becoming a reference discipline (Serenko & Bontis, 2013).

There is no uniform definition of national intellectual capital. National intellectual capital is described as "all intangible resources available to a country or region, which give relative advantage, and which in combination are able to produce future benefits" (Andriessen & Stam, 2005). National intellectual capital can also be defined as "knowledge, wisdom, capability, and expertise" (Lin & Edvinsson, 2011) or "national knowledge and knowing capability"(Kapyla *et. al.*, 2012). The benefits of national intellectual capital can be explicitly defined as "competitive advantage" (Lin & Edvinsson, 2011), "future growth potential" (Lin & Edvinsson, 2011), "wealth creation" (Bontis, 2004; Lazuka, 2012), "society's value creation" *(Kapyla et. al.*, 2012), and "economic, social and environmental development" (Salonius & Lönnqvist, 2012). Even if definitions used by scientists differ, the basic assumption underlying national intellectual capital term is the importance of intangible resources.

National intellectual capital is usually characterized as an aggregate of its structural parts. Various national intellectual capital structural models are used, which differ in the terms used to define components and the level of elaboration. The most popular are intellectual capital model of Scandia Navigator, proposed by Edvinsson and Malone (1987). This model was designed to evaluate company's intellectual capital and later applied to

evaluate national intellectual capital (Beskese *et.al.*, 2014; Bontis, 2004; Lin & Edvinsson, 2011; Malhotra, 2000, 2003; Ståhle *et.al.*, 2015; Užienė, 2014). Structural model of intellectual capital proposed by Stewart (1997) is also used for national intellectual capital measurement by scientists Andriessen and Stam (Andriessen & Stam, 2005; Stam & Andriessen, 2009). Recently Kapyla *et al.* (2012) proposed a new structural model of national intellectual capital. This model extends previous models by adding social capital component. National intellectual capital is divided into four parts: human capital, structural capital, relational capital, and social capital (Kapyla *et. al.*, 2012).

- Human capital represents knowledge, education and competencies of individuals in realizing national tasks and goals (Bontis, 2004).
- Structural capital is intellectual capital hidden in national organizational and technological structures (Malhotra, 2000). This capital consists of R&D and innovation systems, scientific and information communication technologies infrastructure.
- Relational capital is a national asset hidden in a country's international relations.
- Social capital refers to institutions, relations and norms, which compose quality and quantity of social interactions in a specific society (Jianbin *et. al.*, 2014).

Incorporation of social capital into the structure of national intellectual capital improves previous models, as it helps to separate international and domestic relations, which were described under one term „structural capital" in model of Scandia Navigator, also assuming social capital as a separate component in the model helps to describe internal relations and organizational and technological structures separately (in Stewart (1997) model those two aspects were merged under one "structural capital" concept). Based on those arguments, national intellectual capital model of four components (Kapyla *et al.*, 2012) will be used to evaluate national intellectual capital.

National intellectual capital concept strongly resembles the principles of endogenous economic growth theory. Main principle of endogenous growth theory is that economic growth is an endogenous result of economic system and is driven by technology and knowledge. In pursuance to explain this process, scientists included intangible inputs in their analyses. They analyzed human capital impact on economic growth (Becker, 1975; Schultz, 1963; Lucas, 1988; Romer, 1990); R&D investments (Jones, 1995; Romer, 1990); institutional factors (Agénor & Dinh, 2015; Grootaert *et. al.*, 2008; Olson, 1982; Rodrik, 2000; Tabellini, 2010), social capital (Paldam & Svendsen, 2000; Scrivens & Smith, 2013; Woolcock & Narayan, 2000),

international trade (Isaksson, 2007), direct foreign investment (Fukuyama, 1995; Keller, 2009), expansion of information communication technologies (Abdouli & Hammami, 2017; Erumban & Das, 2016; OECD, 2003; Salahuddin & Gow, 2016; Savulescu, 2015; Vu, 2011). These analyses are focused on a certain type of intangible resource, however national intellectual capital tradition covers a wider spectrum of intangibles, namely human capital, structural capital, social capital and relational capital.

National intellectual capital influence to economy is often investigated using correlation analysis. Such studies (Lin & Edvinsson, 2011; López Ruiz *et. al.*, 2011; Weziak, 2007) have found that countries with higher national intellectual capital level have higher levels of GDP per capita. However, correlation analysis cannot prove casual relations. Having a high GDP does not necessarily ensure that growth is driven by intellectual capital: it could be vice versa in that intellectual capital is produced as an outcome of wealth (Stahle, 2008). Andriessen and Stam (2005, 2009) indicate that the evaluated effects are not only a result of intellectual capital, but also the effect of financial wealth. Bontis (2004) takes up this issue and, once having evaluated the Arab states' intellectual capital, he divides countries into rich and poor, and analyses each group separately. Lin and Edvinsson (2011) also investigated separate clusters of countries according to the country's development level and other related factors. It is argued that economic growth drivers are heavily dependent on the level of economic development and thus they are contextual in nature. The effect of a driver varies according to the development stage of the nation and tends to lose its power to enforce economic growth (Stahle, 2008). It is acceptable to analyze groups of homogenous countries in order to identify the true sources of economic growth.

Majority of national intellectual capital measurements have focused on the evaluation of national intellectual capital at specific point of time and its relation with GDP level, however this cannot be regarded as an equivalent measure of its general effect. In order to investigate cause and effect, it is necessary to consider the concepts of time or the concept of inter-related dependency (Stahle, 2008). It is important to transfer analysis focus from GDP levels to GDP growth trends.

National intellectual capital's influence on economic growth measurement methodology

It is difficult to measure national intellectual capital and there is no single way of doing it. National intellectual capital value is usually measured as

an index, which is estimated by aggregating values of its structural parts. Such valuation not only gives tools to calculate the value of national intellectual capital, but also enables to estimate the value of its subcomponents and use those values in further analysis. In this article, national intellectual capital value is estimated by applying the measurement model proposed by Mačerinskas *et al.* (2016) (see Figure 1). This model is based on a structural model of four components (human capital, structural capital, social capital and relational capital), as suggested by Kapyla *et.al.* (2012).

Indicators used for national intellectual capital calculation are described in first level of model. The second and third levels shows latent factors. In order to aggregate values, two aggregation methods are used: firstly, indicators are summarized using refined factor value computation method applying the standardized regression coefficients, then SAW method is employed, by which the value of latent variables is aggregated, and the value of national intellectual capital is calculated. On the second level of proposed model, the SAW method with equal factor scores is applied. Factor scores on the third level of this model were decided by expert evaluation. Direct expert evaluation method was used. Respondents were 21 experts from Lithuania, Latvia and the Czech Republic, who evaluated the weight of each national intellectual component. Evaluation was performed in April of 2016. The calculated Kendall's coefficient of concordance is W=0.358, and this value is statistically significant with the level of significance of 0.01. This shows that the experts displayed a significant agreement of components' weights, and their evaluations can be considered as reliable.

Based on the results of the expert evaluation, the national intellectual capital aggregation function is:

$$NIC = 0{,}22SC + 0{,}28STC + 0{,}32HC + 0{,}18RC$$

where NIC denotes national intellectual capital; SC is social capital, STC is structural capital, HC is human capital, and RC is relational capital. The calculated Cronbach alpha score for defined components equals 0.859 and is above the threshold of 0.7 (Nunnally, 1978). This shows that the composed measurement model is reliable.

The influence of national intellectual capital on economic growth is evaluated using cross-country panel regression method. Three regression models are formed.

First regression model is formed in order to find out how aggregated national intellectual capital value influence economic growth rate. Scientific analysis showed that national intellectual capital is considered to be the

main factor of the long-term economic growth. The first hypothesis is formed:

H_1: National intellectual capital has impact on economic growth

To test this hypothesis, linear regression model will be used:

$$g_i = \beta_0 + \beta_1 dev_{\text{i}} + \beta_2 NIC_i + \epsilon;$$

where g_i is the percentage growth rate of real GDP per capita in country *i* during 10 years period of time, dev_1 is the country's level of economic development in the beginning of the period, NIC_i is a vector of national intellectual capital values in the begining of the period and ϵ is a noise term. This regression incorporates the control variable dev_1 of country's level economic development measured as real GDP per capita in the beginning of the period. The time lag between variables entered in this regression will let us understand if casual relation exists.

The second regression model will help to define how separate national intellectual capital components influence economic growth. This model will allow for identifying whether every component of national intellectual capital has significant influence on economic growth rate. The second hypothesis is formed:

H_2: National intellectual capital components have impact on economic growth

Hierarchical multiple regression method is used. Initial regression model is given below:

$$g_i = \beta_0 + \beta_1 dev_i + \beta_2 HC_i + \beta_3 STC_i + \beta_4 RC_i + \beta_5 SC_i + \epsilon;$$

where HC_i is human capital, STC_i is structural capital, RC_i is relational capital and SC_i is social capital. Statistically insignificant variables are removed using stepwise procedure: backward elimination. This procedure allows identifying national intellectual capital components that have significant influence and shows how they impact economic growth rate.

The third regression model is formed in order to investigate how human capital factors influence economic growth. The value of human capital is calculated by taking the average of two factors: the quality of education factor and the education attainment factor. In scientific literature it is argued that education attainment is becoming less important for economic

growth in developed countries (Stahle, 2008) and importance of human capital quality is often overlooked (Hanushek & Kimko, 2000). This model will let us test whether both human capital factors have influence on economic growth. Third, research hypothesis is formulated:

H_3: Factors of human capital have impact on economic growth

Hierarchical multiple regression method is used. Initial regression model is given below:

$$g_i = \beta_0 + \beta_1 dev_i + \beta_2 HC1_i + \beta_3 HC2_i + \epsilon;$$

where $HC1_i$ is the quality of education factor and STC_i is the education attainment factor.

ANOVA p value will show if the hypothesis can be accepted and if statistically significant impact was found (significance level is 0,05). If the ANOVA p value is less than the significance level of 0,05, it means that statistically significant relation between dependent and independent variables exists (Dudzevičiūtė & Čekanauskas, 2014).

The aforementioned regression models regression models are tested by employing the sample of 25 EU countries; panel data of four time periods is used: 2002–2012, 2003–2013, 2004–2014 and 2005–2015. The data is obtained from the Eurostat database, the World Data Bank, the World Economic Forum database, the European Social Survey database, OECD (PISA survey results), and the data on patents' applications submitted to USPTO and EPO. The data panel had 9.92% of missing values, which were imputed using the multiple imputation procedure: predictive mean matching (PMM). This procedure was applied for the data of each country separately, so the country's values were not influenced by other countries' indicator values.

In order to separate countries into homogenous groups based on their level of economic development (real GDP per capita), hierarchical cluster analysis was used (Euclidean distance metric). Based on dendrogram (see Figure 2) two groups of countries were identified: the first cluster representing countries with higher level of GDP per capita (AT, FI, BE, IE, NL, SE, FR, GB, DE, IT, DK) and second cluster representing countries which have lower level of GDP per capita (LV, PL, LT, HU, EE, SK, BG, RO, CY, ES, GR, PT, SI, CZ). Regression models are tested in all 25 EU countries and in the mentioned clusters of the countries.

The empirical evaluation of national intellectual capital influence on European countries' economic growth

Within the EU real GDP growth varies considerably over time and across countries. Growth fluctuations are higher once shorter period of time is being evaluated. A ten-year period was chosen for the economic growth evaluation, in this way reducing the impact of cyclical fluctuations.

The first regression model investigates whether aggregated national intellectual capital value has influence on economic growth. The final results of the first regression model are shown in Figure 3. In this figure, scandalized β coefficients and coefficient of determination are displayed.

After testing first hypothesis in 25 EU member states it was revealed that aggregated value of national intellectual capital has statistically significant positive impact on economic growth. Also, it was found that economic development level negatively affects the economic growth rate. This indicates convergence process happening in EU countries. The level of economic development has a stronger effect on the economic growth rate than national intellectual capital value. This regression model helps to explain 60 % of economic growth differences across 25 EU countries.

Final results of the first regression model applied to the first cluster countries (higher level of GDP per capita) reveal that the level of economic development does not have statistically significant influence on the economic growth rate. The only statistically significant factor of economic growth in those countries is national intellectual capital. However, it is essential to take into account that coefficient of determination is low and regression can explain only 13,3% of economic growth differences across countries. This finding indicates that aggregated national intellectual capital value is not a very reliable predictor of economic growth rate, and that there are other factors influencing growth that were not considered in this study.

The final results of the first regression model applied in the countries of the second cluster (lower level of GDP per capita) indicate that both explanatory variables have statistically significant influence on economic growth rate. Those two variables help to explain 82,5% of economic growth differences across countries and this is higher percentage than was monitored once analyzing 25 EU countries. The nature of the relations among variables is the same: national intellectual capital has a positive impact and level of economic development has a negative impact on the economic growth rate.

The findings of the first regression prove that the first hypothesis can be confirmed, and national intellectual capital has statistically significant influence on economic growth.

The second regression model evaluates the impact of national intellectual capital components on economic growth. The final results of the second regression model are depicted in Figure 4.

The analysis of national intellectual capital components in 25 EU countries proves that not all of them have statistically significant influence on economic growth. Structural capital, relational capital and social capital were removed from regression, as their significance level was lower than the threshold. Only human capital and level of economic development influence on economic growth was found to be statistically significant. Human capital has a positive impact on economic growth and the level of economic development is related to lower economic growth.

The analysis of national intellectual capital components in the countries of the first cluster reveals that social capital is highly correlated with human capital (correlation 0.907) and this causes a problem of multicollinearity. For this reason, social capital was removed from final regression. All other national intellectual capital components (structural capital, human capital and relational capital) have statistically significant influence on economic growth. Interestingly, human capital was found to have a negative impact on economic growth. This finding will be explored further in third regression model.

The final results of the second regression model in the second cluster countries indicate that only human capital and the level of economic development have statistically significant influence on economic growth. Human capital positively influences economic growth. The second regression model explains 82,8% of economic growth differences between second cluster countries. The negative influence of the economic development level shows that countries are undergoing convergence.

The results of the second regression have showed that not all national intellectual capital components have statistically significant influence on economic growth. Once analyzing 25 EU countries and countries which had lower level of GDP per capita, it transpires that only human capital influence is statistically significant. In countries with a higher level of GDP per capita, human capital, structural capital and relational capital have statistically significant influence on economic growth.

The third regression model helps to depict how factors of human capital influence the economic growth rate. Final results of the third regression model are depicted in Figure 5.

An analysis of human capital factors' influence on economic growth in 25 EU countries has showed that the factor of education quality does not have significant influence on economic growth. The education attainment, on the other hand, has a positive statistically significant influence on the economic growth.

In the first cluster countries, both human capital factors have significant influence on the economic growth. However, those factors have different impact: education attainment factor has positive impact, and the quality of education factor has negative impact. From scandalized β one can see that education attainment is a more important factor for economic growth in countries with higher economic development level. Increasing level of education attainment in those countries adds up to their future economic growth rate, but a high value of education quality indicators is not related to higher economic growth levels. On the contrary, higher level of education quality factor is related with lower economic growth.

The final results of the third regression model in the second cluster countries have showed that the education attainment factor does not have statistically significant influence on economic growth. In those countries, only the quality of education factor and the level of economic development have significant influence on economic growth. Indicators of education quality have a positive impact. This means that if countries from this cluster increase the quality of education, they might be able to achieve a higher level of economic growth.

The results of the third regression model showed that human capital factors differently affect economic growth. In 25 EU countries and countries with a higher level of economic development, positive impact of education attainment factor could be seen. However, this factor does not have influence on economic growth in countries with lower economic development. In those countries, the factor of education quality possesses a positive impact on economic growth.

Discussion

The aforementioned regression models allowed for analyzing national intellectual capital influence on economic growth in different levels of aggregation. Comparison of those tree regression models shows that the third model, the final version of which is composed only of education attainment and economic development level, is able to explain the highest portion of differences in economic growth in 25 EU countries. In 25 EU countries, the aggregated indicator of national intellectual capital is able to explain more

variance than separate national intellectual capital components, but still less than education attainment factor.

In countries with a higher level of GDP per capita, the second model is able to explain the greatest part of differences in economic growth rate. This model is composed by structural capital, human capital, relational capital and level of economic growth. In those countries, aggregated value of national intellectual capital is not the best indicator for predicting the economic growth rate.

In countries of lower level of economic development, all regression models explain a similar portion of variance. The model which requires fewer variables for explaining the same phenomena can be treated as better in comparison with others. The third model can be considered to be the best option in order to explain economic growth in the second cluster countries. This model stresses the importance of education quality indicators, which have positive impact on economic growth.

Conclusions

National intellectual capital concept provides background for the assessment of integrated intangible assets. Different interpretations of national intellectual definition exist, but all of them share idea of national intellectual capital as a valuable intangible resource. Structural models of national intellectual capital provide more details about the types of intangibles that are included into this concept, also structural model is used as a basis for evaluation model. Several structural models of national intellectual capital exist, but in this article a model of four components is used: human capital, structural capital, relational capital and social capital.

In scientific literature national intellectual capital influence on economic growth is often investigated using correlation analysis. Even though majority of studies reports positive correlation, which shows that a higher level of intellectual capital is present in more economically developed countries, this does not allow to conclude that casual relation between national intellectual capital and economic growth exists. In order to improve research in this field, it was suggested to investigate the relations between concepts that measure separate time periods. National intellectual capital is measured in the beginning of the period and economic growth indicator shows growth during the period of 10 years after. This approach enables the assessment of casual relations between economic growth and national intellectual capital. The proposed research methodology allows to thoroughly analyze the national intellectual capital influence on economic growth, i.e. to find out not

only the influence on economic growth that is made by the aggregated national intellectual capital indicator, but also to identify how separate components of national intellectual capital impact the economic growth. Differences of national intellectual capital influence on economic growth were investigated taking into account distinct cluster of countries and all of 25 EU countries altogether.

Empirical analysis has confirmed that national intellectual capital has positive impact on economic growth. The analysis of intellectual capital components' influence on economic growth rate revealed that human capital is the only national intellectual capital component having significant positive impact on economic growth in 25 EU countries and in countries with the lower level of economic development. In countries with higher economic development level only social capital does not have significant influence on economic growth, with all other national intellectual capital components having statistically significant influence. The impact of human capital factors on economic growth varies depending on the group of countries that are being analyzed. Once analyzing 25 EU countries and countries with higher level of economic development, positive impact of education attainment factor is observed. However, in countries with lower level of economic development, education attainment factor does not have statistically significant influence. In such countries, the factor of education quality has positive influence on economic growth. Countries with lower level of economic development should pay attention to the quality of their education system as this was identified as a factor determining their economic growth rate.

This research allowed to evaluate national intellectual capital and its components' impact on economic growth in EU countries. However, investments into national intellectual capital and their effectiveness have not been analyzed. Research in this area could provide better understanding of investments needed to increase level of national intellectual capital.

In countries with lower economic development level it is recommended to pay more attention to education quality and search for ways how to improve it. In countries with higher economic development level structural and relational capital has positive effect on economic growth. Those counties could improve their economic growth level by improving those areas.

One of the main national intellectual capital evaluation limitations is subjective selection of national intellectual capital structural model and the evaluation parameters. In the light of absence of relevant indicators, a part of the qualitative aspects of the national intellectual capital has not been assessed. The second limitation is insufficient panel data sources. The data did not allow for inclusion of longer study period and more countries. Last-

ly, the subjectivity of evaluation parameters' values aggregation method is considered to be a study limitation. In order to reduce the subjectivity, a combination of standardised regression coefficients' calculation and the SAW methods was used. However, a blend of those methods does not allow for avoiding subjectivity completely. While using standardised regression coefficients calculation method, subjectivity arises in choosing factors' extraction method; meanwhile, summarizing indicators using the SAW method, there is certain subjectivity in determining the weights of constituents. Future research could be oriented towards finding ways how to overcome those research limitations.

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Annex

Figure 1. National intellectual capital measurement model

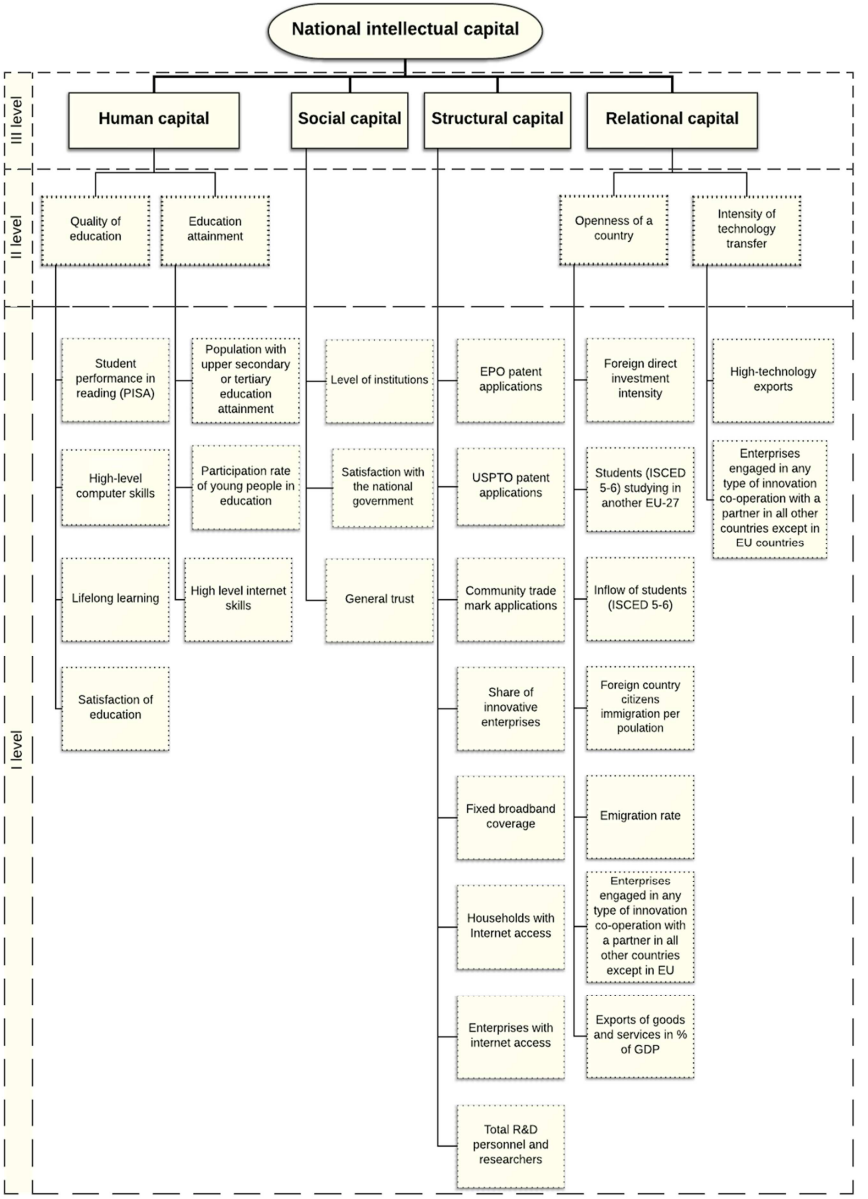

Figure 2. Dendogram. Clusters formation based on EU countries‘ real GDP per capita value

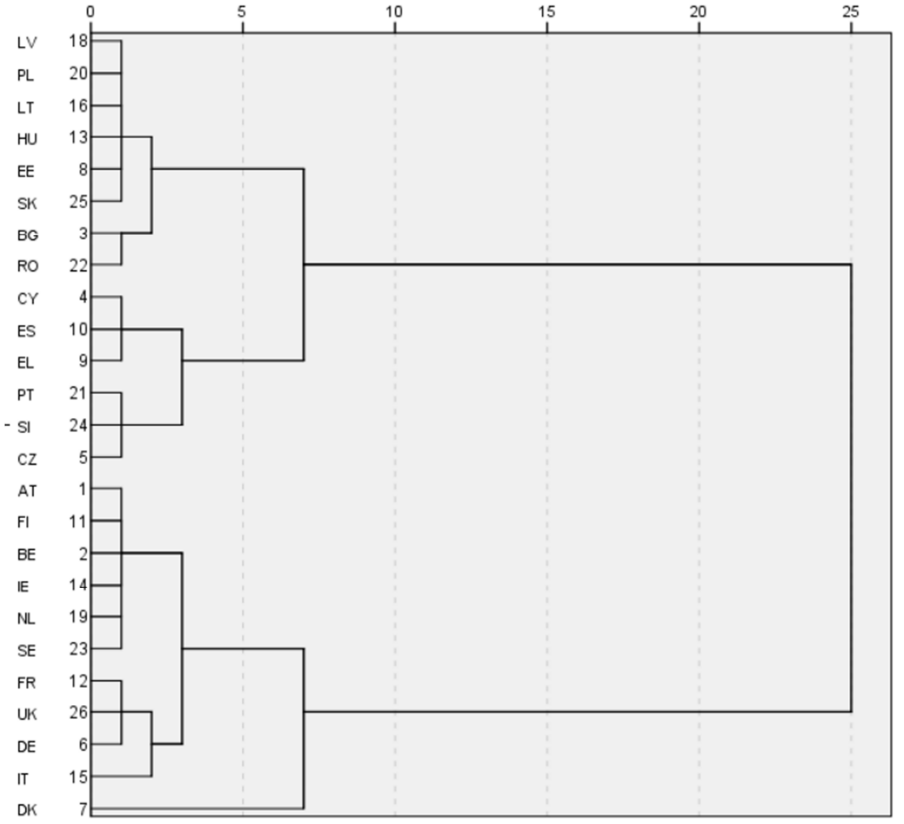

Figure 3. First regression model results

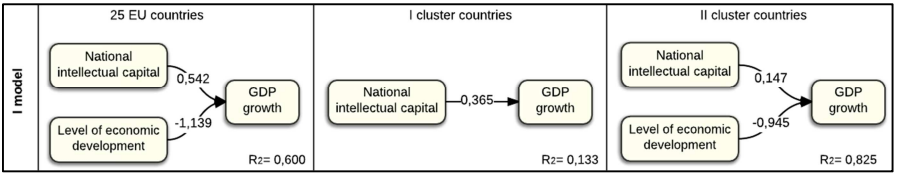

Figure 4. Second regression model results

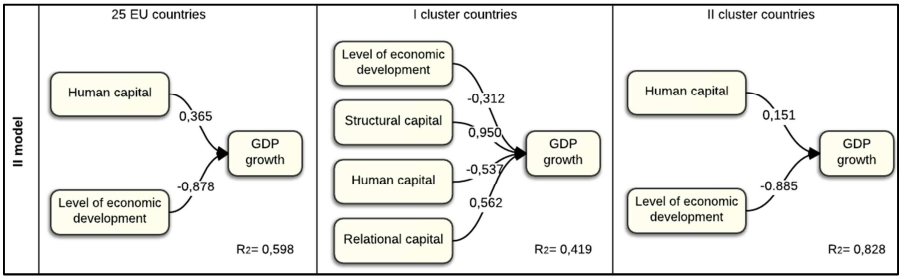

Figure 5. Third regression model results